AD

65-781

EFFECT OF CONVENTIONAL LUBRICANTS UPON RESIN-BONDED SOLID FILM LUBRICANTS

TECHNICAL REPORT

BY

Robert L. Young

March 1965

U. S. ARMY WEAPONS COMMAND

ROCK ISLAND ARSENAL
RESEARCH & ENGINEERING DIVISION

The effect of conventional lubricants upon the wear life and corrosion protection afforded to steel surfaces by two resin-bonded solid film lubricants is listed.

The following information was obtained from this investigation:

1. When a resin-bonded solid film lubricated surface is contaminated with conventional lubricants and the contaminant is not thoroughly removed, the wear life was generally lowered.

2. Certain of the conventional lubricants lessen the corrosion protection while others have no significant effect on the corrosion protection afforded by solid film lubricants.

by R. L. Young
Rock Island Arsenal
Rock Island, Illinois

Effect of Conventional Lubricants Upon RESIN-BONDED SOLID FILM *Lubricants**

OBJECT

To determine how conventional oils, greases and hydraulic fluids affect the wear life and corrosion protection afforded by resin-bonded solid film lubricants.

INTRODUCTION

Army applications for resin-bonded solid film lubricants are becoming more numerous. A solid film lubricated surface is not readily discernable, especially to personnel in the field. Consequently the probability that conventional lubricants would be applied over dry film lubricants either intentionally or accidentally is always present. During the past several years that this laboratory has been investigating solid film lubricants, contamination with conventional oils, greases or rust preventives occurred on occasions. If such contaminants were not completely removed the wear life of the solid film lubricant was usually reduced.

A thorough investigation of the total effect of the conventional lubricants upon the solid film lubricants became imperative. Because of Army demands that a solid film lubricant protect against rust and corrosion, as well as lubricate, this factor was also included in the investigation. Methods of counteracting any deleterious effects of such lubricants were considered, so that effective decontamination measures could be recommended.

*The ascertations or opinions expressed herein are those of the author and do not necessarily represent those of the Army Materiel Command.

Presented at the 19th ASLE Annual Meeting in Chicago, May 26-28, 1964

"Reprinted by special permission from the American Society of Lubrication Engineers from the June 1964 issue of Lubrication Engineering."

PROCEDURE

A. The effect of conventional lubricants on the corrosion protection afforded by resin-bonded solid film lubricants was determined by exposing 2 x 3 inch panels made from AISI 1020 steel, in the 20% salt spray cabinet using Federal Test Method 4001.1 (1). The panels were treated as follows:

1. 78 panels were grit blasted to a surface finish of 145 — 155 microinches rms. then zinc phosphatized in one batch, according to Specification MIL-P-16232b, Type 2, Class 3 (2).

2. Half of the panels were coated with resin-bonded solid film lubricant A (developed at this Arsenal) (3). This lubricant consisted of molybdenum disulfide, a synergistic metallic oxide and a small amount of an acid acceptor dispersed in an epoxy-phenolic resin system. The other half of the panels were coated with lubricant B (a proprietary material). This lubricant is believed to be mainly molybdenum disulfide in an unknown type of thermosetting resin. The coatings were applied by dipping the panels in the lubricant for approximately 5 seconds, hanging on a rack to air dry for 30 minutes then placing the rack in an oven heated to 400 F ± 5 F to cure for one hour; this resulted in a coating thickness of .0004 to .0006 inches.

3. Lubricant coated panels, in triplicate, were immersed in each of the conventional lubricants, listed in Table 1, for one minute then hung in an oven maintained at 125 F ± 2 F for one week.

TABLE 1.—CONVENTIONAL LUBRICANTS USED

LUBRICANT	SPECIFICATION INVOLVED
1. All purpose grease	MIL-G-10924B
2. Diester base grease	MIL-G-3278A
3. Silicone grease	
4. Polyglycol grease	
5. Engine lubricating oil, Grade 10	MIL-L-2104B
6. Preservative lubricating oil, general purpose	MIL-L-644B
7. Universal gear lubricant	MIL-L-2105B
8. Preservative lubricating oil, medium	MIL-L-3150
9. Lubricating oil, synthetic base	MIL-L-7808D
10. Preservative oil, hydraulic	MIL-O-6083A
11. Hydraulic fluid, petroleum base	MIL-H-5606A
12. Hydraulic fluid, petroleum base (special)	MIL-H-13866A

4. The conventional lubricants were then completely removed from the panels by dipping in several changes of warm (125 F) dry cleaning naphtha conforming to Fed. Spec. P-D-680 and hung at room temperature until dry.

5. The panels were then exposed in a 20% salt spray cabinet operated at a temperature of 95 F and a solution collection rate of 1.0 to 1.4 ml. per hour. Failure was designated as the number of hours required for the three rust dots to appear on at least two of the three test panels.

Three control panels were put through the same procedure with the exception of section 3.

B. The effect of conventional lubricants on the wear life afforded by resin-bonded solid film lubricants was determined by means of the Falex Lubricant Tester. Falex pins and V-blocks, made from AS1 3135 steel and 1137 steel respectively, were treated as in Procedure A, Parts 1 and 2. The solid film coated specimens, enough for triplicate tests, were placed in 50 ml. beakers and covered by each of the conventional lubricants. The beakers were then placed in an oven maintained at 125 F ± 2 F for one week. The specimens were then left immersed in the conventional lubricants at room temperature until they could be run in the Falex Machine. The specimens were run at a constant jaw load of 1000 pounds or approximately 50,000 psi in three series of conditions as follows:

Series I, with the test specimens wet with the conventional lubricant.

Series II, with the conventional lubricant removed as completely as possible with clean tissue paper.

Series III, with the conventional lubricant removed by several washings in warm (125 F) dry cleaning naphtha.

The criterion for lubricant failure was an increase of 10 inch-pounds torque above the initial steady state torque at 1000 pounds jaw load. Wear life was the time in minutes at which the increase in torque was observed. Nine control tests were run with each solid film lubricant, preparing specimens according to Procedure A, Parts 1 and 2.

RESULTS AND DISCUSSION

Results of the 20% salt spray test, listed in Table 2, show that, with solid film lubricant A coated panels, five of the conventional lubricants had no effect on the corrosion protection, while 7 had varying adverse effects on the corrosion protection afforded by the solid film. With solid film lubricant B, which, according

TABLE 2.—SALT SPRAY PROTECTION AFFORDED BY SOLID FILM LUBRICANTS

CONVENTIONAL LUBRICANT	HOURS TO FAILURE ZINC PHOSPHATIZED STEEL PANELS	
	COATED WITH SOLID FILM LUBRICANT A	COATED WITH SOLID FILM LUBRICANT B
1. All purpose grease	124	2
2. Diester grease	72	3
3. Silicone grease	96	1
4. Polyglycol grease	200	2
5. Engine lub. oil, grade 10	200	5
6. Pres. lub. oil, general purpose	48	2
7. Universal gear lub.	120	1
8. Pres. lub. oil, medium	146	2
9. Lub. oil, synthetic	170	1
10. Pres. oil, hydraulic	170	1
11. Hydraulic fluid, petroleum base	120	2
12. Hydraulic fluid, petroleum base, special	170	2
None	200	2

TABLE 3.—FALEX WEAR LIFE OF SOLID FILM LUBRICANTS AFTER EXPOSURE TO OILS AND GREASES (MINUTES)

CONVENTIONAL LUBRICANT	Solid Film Lubricant A *I	Solid Film Lubricant A II	Solid Film Lubricant A III	Solid Film Lubricant B I	Solid Film Lubricant B II	Solid Film Lubricant B III
1. All purpose grease	1	299	438	14	4	261
2. Diester grease	10	326	400	23	2	250
3. Silicone grease	0	371	441	0	70	252
4. Polyglycol grease	10	301	7	5	8	276
5. Engine lub. oil, grade 10	17	500	457	43	4	234
6. Pres. lub. oil, general purpose	1	391	347	47	5	173
7. Universal gear lub.	20	568	437	347	4	230
8. Pres. lub. oil, medium	19	509	277	62	2	207
9. Lub. oil, synthetic	15	485	355	23	5	164
10. Pres. oil, hydraulic	4	552	463	10	8	108
11. Hydraulic fluid, pet. base	2	597	459	12	43	249
12. Hydraulic fluid, pet. base special	2	581	452	6	8	238
None, av.		384			235	

*I - Lubricant not removed.
II - Lubricant removed by wiping.
III - Lubricant removed with naphtha.

to control panels, produced a coating with less corrosion protection ability, six of the conventional lubricants had no effect on the corrosion protection, three increased it and three shortened the corrosion protection. The repeatibility of the salt fog test has not been established. Neither has the standard deviation. The general concensus is that the results are considered equivalent unless they deviate more than ± 20%. Upon this basis, the above conclusions appear reasonable.

The effect of conventional lubricants on the wear life of the solid film lubricant coating is shown in Table 3. The following observations appear valid:

1. When resin-bonded solid film lubricated surfaces become wet with any conventional lubricant and the lubricant is not removed (Series I), the wear life of the solid film coating is greatly reduced. In the one exception, solid film lubricant B coated specimens, wet with conventional lubricant No. 7, the extended wear life was attributed to the gear oil and the additives present.

2. When resin-bonded solid film lubricated surfaces become wet with conventional lubricant and the lubricant is removed as completely as possible with clean tissue paper (Series II) the wear life of the solid film coating was uncertain. In the case of solid film lubricant A, the wear life was restored to near or better than that of the average control. With solid film lubricant B, the wear life was greatly reduced, in most instances, to less than the value of the corresponding Series I condition. The standard deviation of the wear test is about ± 20 minutes.

3. When resin-bonded solid film lubricated surfaces become contaminated with a conventional lubricant and the lubricant is removed completely with several washings in warm (125F) dry cleaning naphtha, the wear life of both lubricant A and lubricant B was restored to near that of the lubricant before contamination. There are some unexplainable fluctuations in the wear life for some lubricants, however, so only the general trend can be stated.

There was one exception to this observation in the case of Solid Film Lubricant A. After removing the conventional lubricant No. 4, a polyglycol grease, the wear life was greatly reduced. This was true of all three tests run.

Contamination with conventional lubricants in general, appears detrimental to a solid film lubricant (4). The degradation depends upon the grease or oil involved and also upon the formulation of the dry film lubricant. The cause of this degradation has not been fully established. It may be due to a softening of the resin binder. Crump (4) discusses this possibility and also proposes another one. He suggests that the oils penetrate between the fibers of the binder and when subjected to a load the pressure tears the fibers apart and loosens them from the metal. Observations in this Laboratory tend to support this latter theory. Either occurence could explain the observed lowering of wear life.

SUMMARY

Conventional lubricating oils and greases in general, have a deteriorating effect upon resin bonded solid film lubricants. This adverse effect can be practically nullified by removal of the contaminating oil or grease by washing with a solvent. Wiping with a cloth helps in some cases but is generally not as effective as washing with naphtha.

REFERENCES

1. Federal Test Method 4001.1, Federal Test Method Standard No. 791.
2. Military Specification MIL-P-16232B, Phosphate Coatings, Heavy, Manganese or Zinc Base, For Ferrous Metals.
3. Rock Island Arsenal Purchase Description, R.I.A. PD-651, Lubricant, Dry Film, Resin Bonded.
4. WADC Tech. Report No. 57-93 "Proceedings of Air Force-Navy-Industry Conference on Aircraft Lubricants," Mr. Ralph E. Crump, Page 398. June 1957.